Massachusetts Institute of Technology
Charles Stark Draper Laboratory
Cambridge, Massachusetts

LUMINARY MEMO # 155

TO: Distribution

FROM: B. J. McCoy

DATE: 1 June 1970

SUBJECT: Luminary 1D re-release

Due to the bugs that came out of the woodwork after the May 5 release of
Luminary 1D, the program was judged to be non-flight worthy. The following
bugs were fixed and are listed below. The rope release date for these changes
is 16 June 1970.

1.   Implementation of ACB L 20-
          An error was made in reading assembly card numbers: 2234 vs
          2334. By coincidence, they are concerned with the same noun
          (60) in the NOUN Tables (output and input scaling). The fix makes
          the output scaling 0.5571 fps/bit and the input scaling the way it was
          originally, though it is not intended for use.

2.   Implementation of PCR 988-
          The Restart point in P66 was moved down four places to (1) pre-
          vent the AstrPro flag from being set by a Restart if it had been reset
          to turn off RCS jets (2) prevent a possible 1466 alarm if a P66 omission
          occured with a Restart.

3.   Implementation of PCR 896-
          (LMS/KSC). The landing Radar Velocity Reasonableness test could
          fail erroneously due to Service being too fast. It starts to process
          LR velocity data before the complete set of radar readings are
          taken for a particular velocity beam. The fix is flowed below.
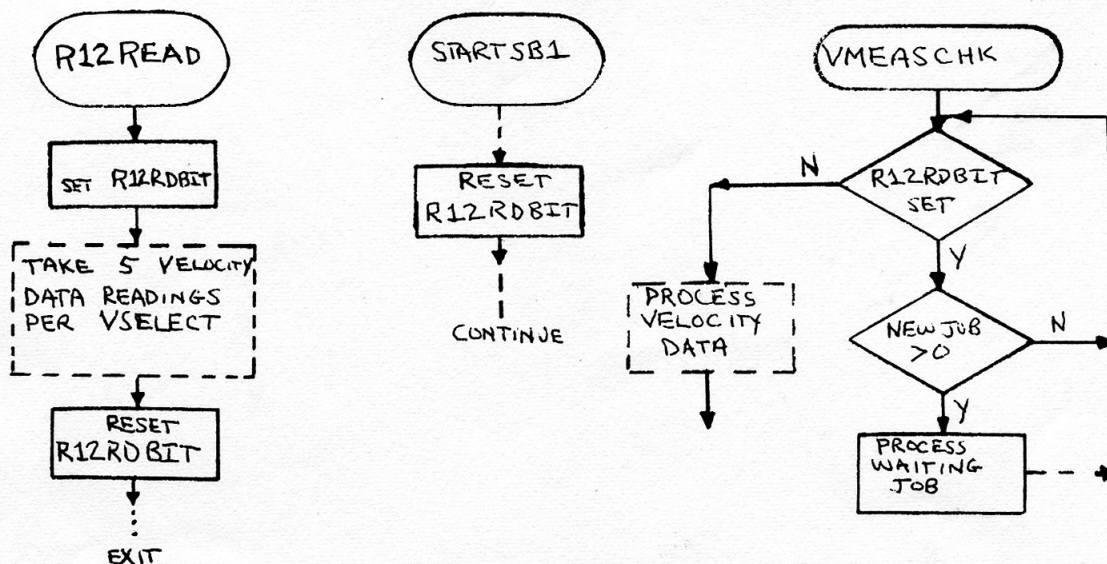
R12RBIT is flagword 11 bit 3. This was concurrently discovered by Robert Force, NASA (LMS/MSC) but has not to this date been seen on the FMES at GAEC. A special case, i.e. no alt data good and a V68 terminating the a priori terrain model computations, produced 9 failures at MIT/CSDL.

4. Elevation angle fake out-

the shortened Rendezvous being used on the LMS's for crew training showed that the elevation angle in P34 (ELEV) shares an erasable cell that could cause a problem. At the time it shared with YDOT, the cross axis velocity to which Ascent Guidance is steering. It usually is a very small number; thus, when P34 displays its DP number in NOUN 55, it could appear to the astronaut as +00000. If he wants to compute an Elevation Angle based on a TPI TIG, he probably would not load zeros himself (it looks zero to him, even though it could be a very small non-zero number). This results in a 611 alarm, no Elevation angle for given TIG. The fix put in was to 1) initialize ELEV to zero in P34 before it is displayed and 2) don't share it with YDOT, but where it used to be (in Luminary 1C). (Subsequently reported by R. Force)

5. Implementation of L-1C-01-
A restart point was inserted in a subroutine (S40.8) which returned to the caller via QPRET, which is in the VAC area. Since a particular VAC will not necessarily correspond to the same job after a restart has occurred, the expected return (QPRET) could be anything and, thus, a random transfer is probable following a restart during subroutine S40.8 of P4X. This was corrected by making a direct transfer back from S40.8 to the calling routine UPDATEVG (X product steering).

6. Implementation of PCR 1013-
TOO FEW, the erasable governing the occurrence of a 1466 alarm if P66 issues "too few" throttle commands for everyone omitted (by TLOSS) shares with a P30 erasable and also with a Descent thrust/guidance erasable. It could result in an erroneous 1466 alarm should TLOSS be high enough to cause a P66 omission (now $>10\%$). It was moved to an unshared, unswitched erasable location (1354).

Attached are additional Level III and IV tests to be performed as a result of these changes.

The known problems existing in Luminary that will not be fixed until Luminary 1E are as follows:

1. Luminary anomalies L-1C-01 and L-1C-02

2. "LRPOS" initialization in P63 is reversed

3. a DDOUBL instead of a DOUBLE in Throttle Control logic- effect is 2.7 lbs thrust

4. a V37 following within 10 sec of a V40N20 (CDU zero) turns off DAP

5. Altitude Rate on tape meter glitches periodically: unresolved

6. Cross Pointer - P66 Auto inconsistency: unresolved

7. "LRWH1" overlays "RM" of P20

8. DXCH instead of XCH in Throttle Control Logic - affects only Throttle recovery

9. Display conflict in P20's with extended verbs

10. Predesignate flag in P22 incorrectly used

11. "LRWH" is not updated for P63 - P66 interface: unresolved

Corrections to Memo #148

1. Landing Radar beam on Terrain Model Graphs should have opposite polarity

2. for PCR 1029 SERVDURN is loaded with the difference between TIME 1 and PIPTIME +1 (least significant halves) just prior to Average G exit.

3. for PCR 315.2, channel 76 is not really a spare as such. The channel is available for hardware assignment.

4. for PCR 897 should read ". . .to compensate for a hardware change in the Doppler Ranging Unit. . ."

PCR 1052 was implemented into the re-release to account for the IMU sensing vertical acceleration in P66 when the PIPA's are read while Spacecraft attitude rate is present. The result before the PCR implementation was throttle oscillation commonly referred to as "throttle castellation." Now, when the present acceleration due to thrust is computed (i.e. the PIPA's are read in P66) the pitch rate as determined by the DAP (OMEGAQ) is multiplied by the offset distance the IMU is from the X axis in the Z direction. This quantity is a measure of the Delta Velocity sensed by the PIPA's due to the IMU rotating ("bobbing") around the center of gravity and is subtracted from the total Delta V measured by the PIPA's for that P66 one-second pass. Navigation is in no way affected by the bobbing or the correction.
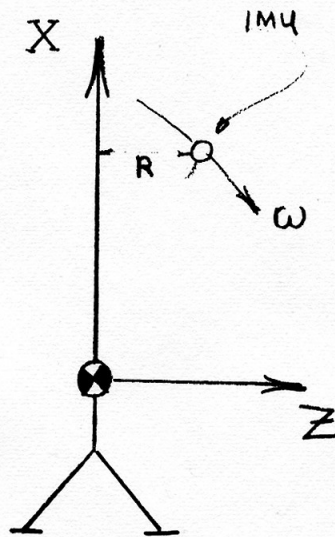
$$\Delta V_x = \Delta V_x - \omega \cdot R$$

Level III Addendum

Test Plan for Lummary 1D (rev 163+)

Prepared by: McCoy

Date: 5/28/70

1. Test scaling of NOUN 60 R1-<u>ACBL20</u>

   a. Dump FORVEL (during Descent, for edit) at VERTDISP

   b. Edit will print out value scaled at 0.5571

   c. Compare to DSKY at corresponding time

2. Test Restart point in P66 - PCR 988

   a. cause a Restart in P66 (with 10%) TLOSS) after P66 omission having "PRO"ed on NOUN 60

   b. show that "P66 PROFL" remains reset and no 1466 alarm occurs

3. Test R12 velocity radar readings <u>PCR 866</u>

   a. w/o alt data good, w/v68 - show that R12 waits; note time margin and compare duty cycle to run before this fix

   b. w/ alt data good, w/o v68 - show that R12 doesn't wait; compare duty cycle to run before this fix

   c. do (a) above with 10% TLOSS

   d. do (b) above with 10% TLOSS

4. Test that ELEV (DP) is initialized to zero in P34-<u>PCN 1048</u>

   a. pad load posmax into ELEV - trace coding to show proper load and note R2 of NOUN 55 equals zero.

   b. use old level 4 test NEWROT (rollback) to show that Lambert computes good ELEV for TIG loaded.

5. Test P40 restart fix: <u>L-1C-01</u>

   a. Trace S40.8 to show direct transfer back to UPDATEVG which had called it.

   b. Cause a Restart during S40.8 and trace as in (a).

6. Test TOO FEW doesn't share, period: <u>PCR 1013</u>

   a. show that TOO FEW does not change during an entire landing

Level IV Addendum
Test Plan for Luminary (rev 163+)

Prepared by: McCoy
Date: 5/28/70

Rerun previous Level IV with following additions:

4.1.1   Nominal Automatic Landing
   a. call P20 in no-update mode (V95E)
   b. call P30 to load any $\triangle V$ into NOUN 81 at TIG of PDI +1 minute
   c. Trace loading of LRWH1 into LRWH
   d. Rollback ANEWROT and load the proper value via V21N01E,
       XXXXXE in P64 prior to data good after antenna reposition

4.1.2   Nominal Landing w/ Redesignations
   a. Trace 1st Pass through R12 to show proper re-initialization.

4.4.0   Surface Operations
   a. call P22 when Range to CSM > 400 n. mi.
   b. when V16N54 appears, call R47 via V47E
   c. note any discrepancy